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The Polyporaceae of North America. I. The Genus *Ganoderma**

BY WILLIAM ALPHONSO MURRILL

It is evident, even to the beginner in mycology, that the present classification of the higher fungi is not satisfactory. This is particularly true of the group containing *Polyporus* and its allies, which is at present very imperfectly divided into genera, and contains many species which are confused and uncertain, because of the incompleteness of the original descriptions. Before the group can be reduced to order, full descriptions must be had of all its species, the type specimens in Sweden, England, Germany, and elsewhere must be examined, and sufficient knowledge gained of the life and habits of each plant to determine its natural position in the group. In this paper an attempt is made to present in order the members of the "*lucidus*" group of *Polyporus* occurring in North America. A large number of the specimens examined have been collected during several years past by Professor Lucien M. Underwood, and by various contributors to his private herbarium. The extensive literature and large collections of the New York Botanical Garden and Columbia University have also been most generously placed at the writer's disposal.

I desire also to express my appreciation of the many courtesies extended me by Professor Paul Magnus, Mr. P. Hennings, Professor Kjellman, Professor T. M. Fries, Professor H. Von Post, Mr. Lars Romell, Mr. W. B. Hemsley, Mr. George Massee and others, while studying forms of this group in Germany, Sweden, and England.

HISTORY OF THE GENUS

The species upon which this genus was founded was first described in its immature form as an agaric, but when perfect specimens were obtained it was placed in *Boletus*, a genus established by Dillenius in 1719 to include all pore-bearing fungi, and later adopted by Linnaeus, although Micheli had erected

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the genus *Polyporus* as early as 1729. *Polyporus* was used by Persoon in his Synopsis only as a subgenus under *Boletus*, from which position it was later raised by Fries to equal rank with *Boletus* and made to include the woody forms of pore-bearing fungi. In 1851, Fries tried the experiment of breaking *Polyporus* up into *Fomes*, *Polystictus*, and *Poria*, a division which, though discontinued in his later works was resurrected by Cooke in his *Praecursores* in 1885 and adopted by Saccardo and others since.

When a systematic arrangement of the Polyporaceae of Finland was undertaken by Karsten (Rev. Mycol. 1881), one of the new genera established was *Ganoderma*, which was based upon the laccate character of pileus and stipe and embraced *Polyporus lucidus* only. In Karsten's "Finlands Basidsvampar" published in 1889, *Ganoderma* is characterized as follows: "Basiderna 4-sporiga, n. klotrunda, cystiderna icke anmärknings värda. Sporererna äggrunda eller elliptiska, värtiga, gulbrunaktiga." Although no mention is here made of the laccate pileus and stipe, no other species are included with *G. lucidum* in the genus. As a synonym of *Ganoderma*, Karsten here mentions *Placodes Quél.*, which genus was erected in 1886 to include a variety of forms which were "covered with a hard crust, without zones or concentrically sulcate, persistent, woody." Along with *P. lucidus* in one of the subdivisions are placed also *P. dryadeus*, *P. resinosus*, *P. erubescens*, and *P. helveolus*.

The transfer of *G. lucidum* from *Ganoderma* Karst. to *Phaeoporus* Schroet. in Schroeter's flora of Silesia was a violation of modern principles and consequently could not meet with general favor. In 1887, Patouillard, following the lead of Quélet, extended the range of *Ganoderma* to include all forms of Polyporaceae with colored spores, adhering tubes and shining crusted pilei; and in 1889 he published a partial monograph of the genus as extended, listing forty-eight species, which were arranged in subgroups upon spore characters. As to the wisdom of so broad a treatment of the genus mycologists appear to be divided. The following synopsis includes only those species which, while essentially alike in internal structure, possess a shining varnished surface produced by the exudation and hardening of a reddish juice similar to that found in *G. pseudoboletus*.

Synopsis of the North American Species

- | | |
|---|------------------------------|
| 1. Context pallid to tawny. | 2. |
| Context umbrinous-chestnut. | 5. |
| 2. Spores over $6\ \mu$ long, verrucose, ferruginous. | 3. |
| Spores less than $6\ \mu$ long, smooth, pale; pileus less than 3 cm. broad, margin entire; tubes not stratified. | 4. <i>G. parvulum</i> . |
| 3. Context ochraceous to fulvous; plants stipitate or sessile, growing on deciduous trees. | 4. |
| Context pallid; plants usually stipitate, annual, growing on hemlock. | 1. <i>G. tsugae</i> . |
| 4. Plants stipitate, or rarely sessile, perennial; margin of pileus truncate at maturity. | 2. <i>G. pseudoboletus</i> . |
| Plants sessile, annual; margin of pileus acute. | 3. <i>G. sessile</i> . |
| 5. Spores smooth, pale yellowish-brown. | 6. |
| Spores roughly echinulate, dark brown; pileus sessile, very thick, its diameter decreasing downward; context less than one third the length of the tubes. | 5. <i>G. Oerstedii</i> . |
| 6. Pileus zonate, even; tubes not stratified. | 6. <i>G. zonatum</i> . |
| Pileus sulcate, azonate; tubes stratified. | 7. <i>G. sulcatum</i> . |

1. *Ganoderma tsugae* sp. nov.

A conspicuous reddish-chestnut fungus growing on dead or dying hemlock. Pileus corky to woody, fan-shaped, convex above, concave below, $4-20 \times 5-25 \times 1-4$ cm.; * surface glabrous, uneven, concentrically sulcate, laccate, lustrous, yellowish-red to mahogany-colored, at length black; margin light-yellow, acute, becoming concolorous, truncate, and marked with many shallow furrows, often undulate and at times more or less lobed: context soft-corky, radiate-fibrous, white or nearly so, 1-3 cm. thick; tubes annual, 0.5-0.75 cm. long, 6-4 to a mm., brown within, mouths circular or polygonal, white to light-cinnamon, edges obtuse, becoming acute: spores ovoid, obtuse at the summit, attenuate and truncate at the base, verrucose, yellowish-brown, $9-11 \times 6-8\ \mu$: stipe lateral, ascending, frequently forked, cylindrical, equal, $2-20 \times 1-4$ cm., resembling the pileus in color, surface and context.

This fungus occurs only on *Tsuga Canadensis*, upon the decaying trunks and roots of which it is very abundant. In West Virginia and New York it has been found full grown as early as June, but it may not reach maturity until autumn, when it speedily de-

* These figures indicate length, breadth and thickness respectively. When the stipe is lateral the pileus is an outgrowth from it and length is measured in the direction of this growth. When the pileus is sessile, the tubercle marking the beginning of growth may be considered a lateral stipe much reduced. When the question of length is settled, breadth and thickness need no explanation.

cays or falls a prey to insects. So subject is it to insect attack that recognizable specimens are rare in the herbarium. As its ordinary host is confined to America, there is no reference to it in European literature, unless the plants found on *Picea excelsa* by Karsten in Sweden belong here rather than with *G. pseudoboletus*.

Extensive collections of various forms of this species were made by Professor Underwood at Syracuse, N. Y., in July 1884, and at West Goshen, Conn., August 1896. Miss A. M. Vail brought specimens from Tyringham, Mass., in August 1897.* Professor G. F. Atkinson has figured the species in plate 66 of his work on mushrooms. Wherever the hemlock grows it appears to be common. It is nearly related to *G. pseudoboletus*, but is annual, grows on coniferous trees, decays soon after maturity, and is usually much lighter in weight and paler in substance.

2. *Ganoderma pseudoboletus* (Jacq.)

Agaricus pseudoboletus Jacq. Flor. Austr. 1: 26-27. pl. 41. 1773.

Boletus rugosus Jacq. Flor. Austr. 2: 44. pl. 169. 1774.

Boletus lucidus Leyss. Flora Halensis, 300. 1783.

Boletus obliquatus Bull. Herb. de la France, pl. 7. 1780; pl. 459. 1790.

Polyporus lucidus Fries, Syst. Myc. 1: 353. 1821.

Polyporus laccatus Pers. Myc. Eur. 2: 54. 1825.

Polyporus Curtisii Berk. Kew Gard. Misc. 1: 101. 1849.

A large fungus common on decaying trunks and stumps of deciduous trees conspicuous on account of its brilliant varnished appearance. Pileus corky to woody, usually kidney-shaped, convex above, concave below, 2-20 × 2-25 × 1-5 cm., yellow to reddish-chestnut or black; surface glabrous, shining, laccate, broadly sulcate and usually marked with concentric lines or bands of a darker color; margin white or light yellow, sterile, thin, acute, becoming truncate, sulcate, and concolorous as new strata are added; context soft-corky or woody, radiate-fibrous, concentrically banded, ochraceous above, tawny next to the hymenium: tubes one- to many-layered, the strata varying in distinctness, 0.5-2 cm. long, 3-5 to a mm., brown within; mouths circular to

* During the summer of 1902 fine specimens have been collected in the hemlock grove of the New York Botanical Garden by Messrs. Burnham and George, in Connecticut by Miss White, and in Ohio by Professor A. D. Selby.

hexagonal, white or yellow, at length brown, dissepiments entire, obtuse, becoming acute: spores ovoid, obtuse, at the summit, attenuate and truncate at the base, yellowish-brown, verrucose, $9-11 \times 5-6 \mu$: stipe lateral, excentric, central, or wanting, erect to ascending, $0-30 \times 0.5-4$ cm., equal, irregular, or enlarging above, concolorous, glabrous, shining, laccate, the substance similar to the context and darker at the center.

On living or dead trunks, stumps, or roots of oak, alder, hazel, maple, willow, honey-locust, sweet-gum, and beech in Sweden, Germany, Bavaria, France, England, America and Australia. American material has been examined from New York, New Jersey, Delaware, Pennsylvania, Ohio, Indiana, Kentucky, Michigan, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mexico, and Nicaragua.

This fungus has been found fossil in the lake dwellings of Switzerland and has been known for a long time on account of its conspicuous coloring caused by a thick glutinous juice which exudes from its surface and dries upon it as a thin lustrous coating. Albino or semi-albino forms occur where the coating is lacking or incomplete. In age the varnish disappears and the pileus takes on a grayish weather-beaten appearance. As the young pileus begins to form at the end of the stipe it is white or yellow in color without varnish and somewhat resembles an unexpanded agaric. It is this stage that Jacquin figured and described in his *Flora Austriaca* as *Agaricus pseudoboletus*. Several immature plants were found by him in a grove growing about the base of a dead oak trunk. The description he gives is quite a good one and, taken with the fine colored plate, leaves no doubt as to the identity of the specimens. The succeeding year he collected several mature plants which he described as *Boletus rugosus* as follows:—

“Fungus speciosus putridis arborum truncis innascitur, totus lignoso-coriaceus et persistens. Stipes durus, inaequalis, badius, vernice veluti obductus, calamus vel policem crassus ratione voluminis ipsius fungi, pileum gerit plerumque subdimidiatum, dum laterali ejusdem parti adnecitur. Hic superne planus est, rugosus primum, ex rubro badius et nitidissimus, tandem hepaticus minusque nitens. Corticis pauca substantia est interne coriacea, holoserisea, cinnamomea, tenax atque ad fomitem apta. Substantia tubulosa concolor, crassa, a corticosa separabilis, subtilissime porosa; subtus punctata, in principio pallens, sensim magis cinnamomea; ad cibum inepta. Fungi duo, ex eodem loco exorti, et majores, in tabula proponuntur, hinc atque illuc spectati. Tum fungulus minor; et fungi pars, ut pateant interiora.”

The specimen upon which Leysser's *Boletus lucidus* is founded was collected by Curtis on a decaying hazel stump near London in November, 1780, and figured in *Flora Londinensis*, 4: *pl.* 224. Leysser's description is as follows:—

“*Boletus lucidus stipitatus, pileo coriaceo castaneo lucido sulcis circularibus, poris minutissimis, albis, stipite laterali.*”

Specimens collected by Rev. M. A. Curtis in South Carolina seemed to Berkeley sufficiently distinct from Leysser's plant to constitute a new species, which he thus describes in *Kew Garden Misc.* 1: 101. 1849:—

“Pileus excentric, soft-corky, sulcate, zonate, ochroleucous, in places sanguine-lacquered; stipe elongated, rugose, sanguine-lacquered; hymenium from white to ochraceous, pores punctiform.”

A special study of many specimens called *Polyporus Curtisii* Berk. shows them to be only variations of *G. pseudoboletus* due to age, rapidity of growth, and perhaps to differences in the host. The yellowish form so common in the southern part of the United States is figured by Bulliard and Gillet as also occurring in France, while farther north the color is usually darker and more lustrous, the texture firmer, and the hymenium less stratose. These differences are not sufficiently constant, however, to enable one to separate the forms geographically.

Another interesting variation observed by Langlois in Louisiana is so distinct from the ordinary form of the plant that it might easily deceive the skilled mycologist. Specimens in the Underwood herbarium have the stipe exactly central, the pileus very even and thin, at first deeply infundibuliform with white margin, at length becoming nearly plane, reddish-brown, and polished, with the margin concolorous.

3. *Ganoderma sessile* sp. nov.

A large sessile plant, with wrinkled varnished cap and acute margin, found on decaying deciduous trees. Pileus corky to woody, dimidiate, sessile, imbricate or connate at times, conchate, thickest behind, thin at the margin, 5–15 × 7–25 × 1–3 cm., yellow to reddish-chestnut, at length opaque dark brown; surface glabrous, laccate, shining, radiate-rugose, concentrically sulcate, usually marked near the margin with alternating bay and tawny zones; margin very thin and acute, usually curved down-

ward, often undulate, not becoming truncate, white, at length concolorous: context soft-corky or woody, radiate-fibrous, concentrically banded, ochraceous-fulvous; tubes 0.5–2 cm. long, 5–3 to a mm., brown within, mouths circular or angular, white to grayish-brown, edges thin, entire: spores ovoid, obtuse at the summit, attenuate and truncate at the base, verrucose, yellowish-brown, $9-11 \times 6-8 \mu$.

This species occurs on deciduous trees and has the general habit of *G. pseudoboletus*, from which it differs in being annual and sessile, with a very acute margin and a more rugose surface. So far as I have been able to determine, it does not occur in Europe, and has not yet been figured. Specimens have been collected by Professor L. M. Underwood on decaying oak at Greencastle, Ind., Oct. 1894, and [at White Plains, N. Y., May 1897, and on dead sycamore at Fort Lee, N. J., May 1899, and March 1901. Plants collected by Morgan in the Miami Valley, Ohio, Dec. 1894, were placed under *G. pseudoboletus* and referred to in the following note: "As it grows in this region, the stipe is always more or less deformed and often wanting; the pilei, when sessile, are sometimes imbricated and connate." In Dec. 1896, it was found by C. F. Baker, at Auburn, Ala., and in Nov. 1897, Rev. A. B. Langlois collected it near St. Martinsville, La., on decaying logs in low woods and marked it "Perhaps a form of *F. lucidus*?" Miss Sadie F. Price has recently sent to the New York Botanical Garden from Bowling Green, Ky., two specimens of this plant collected on oak in Nov. 1901, and Feb. 1902. Specimens sent to Kew by American collectors are included there under *G. pseudoboletus*.

4. *Ganoderma parvulum* sp. nov.

A very small sessile fungus shining bay above and honey-yellow below. Pileus woody, nearly circular in outline, attached by a point, convex above, plane or convex below, thickest behind, $2 \times 2.5 \times 1$ cm.; surface glabrous, laccate, azonate, slightly tubercular, very lightly marked with a few concentric furrows, margin acute: context soft-woody, pale ochraceous, 0.5 cm. thick, with dark horny radiations from the point of attachment: tubes not stratified, 3 mm. long, 5 to a mm., umbrinous within, mouths polygonal, honey-yellow, dissepiments entire, obtuse: spores subglobose, smooth, pale yellowish-brown, $4 \times 5 \mu$.

Collected by C. L. Smith in Nicaragua during the winter of

1891-1892. This beautiful little plant is closely related in habit and general appearance to the American species of *Ganoderma* occurring farther north, but it is of much smaller size and its spores are quite distinct in form, size and color. It is possible that the specimens I have are not quite mature.

5. *Ganoderma Oerstedii* (Fries)

Polyporus Oerstedii Fries, Nov. Sym. 63. 1851.

Pileus reniform, ungulate-applanate, gibbous at the base, a foot in diameter; surface horny-incrusted, very glabrous, adorned with shallow furrows, which almost disappear with age, shining reddish chestnut becoming almost black; margin very obtusely truncate and marked with concentric furrows, the upper annual growths exceeding the lower; context partly hard and horny and partly floccose, umbrinous next to the tubes, more tawny beneath the cuticle, very thin in older specimens, the tubes forming the principal part of the pileus: tubes contiguous and hence indistinctly stratified, 3-5 cm. long, umbrinous within, mouths lighter in color, dissepiments entire, obtuse: spores broadly ellipsoid, truncate, very dark yellowish-brown, abundantly and roughly echinulate, $11 \times 9 \mu$.

Two imperfect specimens of this plant are in the herbarium of the New York Botanical Garden, one collected by C. L. Smith in Nicaragua, and the other by C. T. Townsend on an orange tree in Jamaica. These specimens, while corresponding with the Friesian types at Upsala, hardly justify any considerable departure from the Friesian description.

6. *Ganoderma zonatum* sp. nov.

A soft laccate fungus of medium size marked with numerous tawny and chestnut-colored zones. Pileus very soft-corky, sessile, dimidiate, applanate or convex above, concave below, glabrous, zonate, not sulcate, $5 \times 7 \times 1.5$ cm.; margin velvety, acute, becoming obtuse and concolorous: context very soft, floccose, radiate-fibrous, concentrically banded, 0.5 cm. thick, chocolate-brown: hymenium velvety, not stratosed, tubes 1 cm. long, 3-4 to a mm., umbrinous within; mouths white to umbrinous, regular, polygonal, stuffed at first with whitish material, covered 0.5-2 cm. from the margin with yellowish or reddish varnish; dissepiments entire, obtuse to acute: spores elongated ellipsoid, smooth, pale yellowish-brown, $8-10 \times 4-6 \mu$.

Collected by Professor Underwood in Florida. Closely related to *G. sulcatum*, but differing in general appearance, size of pores, and in the extent and arrangement of varnish upon the hymenium. A similar coating of varnish exists in *G. sulcatum* and *G. pseudoboletus* at times, but in neither of these has it been found as a broad distinct marginal band. This band is sometimes split by the growth of the margin and a zone of pores appears between the two laccate portions. Additional material may reveal the existence of intermediate forms connecting this species with *G. sulcatum*.

7. *Ganoderma sulcatum* sp. nov.

A large sessile plant without zones, but marked with a few conspicuous concentric furrows. Pileus corky, dimidiate, sessile or arising from a lateral tubercle, plane or convex above, thickest behind, $8 \times 11 \times 2$ cm.; surface laccate, glabrous, azonate, fulvous to chestnut, deeply sulcate; margin rounded, velvety, ochroleucous, at length concolorous: context very soft, floccose, radiate-fibrous, concentrically banded, 1 cm. thick, umbrinous-chestnut: tubes indistinctly stratified, 1.25 cm. long, 4–5 to a mm., umbrinous within, mouths whitish or yellowish, at length umbrinous, dissepiments entire, obtuse: spores ellipsoid, pale yellowish-brown, smooth, $8-10 \times 4-6 \mu$.

This plant was collected on soft palmetto logs in Florida by Mr. C. G. Lloyd, January, 1897; type in New York Botanical Garden. It is very nearly related to *G. zonatum*.

SPECIES INQUIRENDÆ

Fomes incrustatus Fries, collected in Costa Rica by Oersted. Pileus 5–7 cm. broad, sordid umbrinous, laccate: context scanty, pallid, tubes concolorous; stipe central, torulose, unequal. This species was not transferred by Patouillard to the genus *Ganoderma*.

G. nutans (Fries) Pat., also collected by Oersted in Costa Rica. Pileus scarcely 2 cm. broad, orbicular, pallid to bay-black, laccate; context scanty, pallid, pores pallid to brown; stipe long, slender, twisted as though climbing, recurved at the apex, giving the pileus the appearance of nodding; spores ovoid, brown, echinulate, $12-15 \times 10 \mu$.

Specimens seen in foreign herbaria appear to be very distinct. Fries' description in *Novae Symbolae* 61–62 is quite full and can-

not be improved upon at this time on account of lack of material for critical study.

G. nitens (Fries.) Pat. On trunks in tropical America. Pileus large, sessile, semiglobose, chestnut to black, shining, hanging by a process behind; context umbrinous, tubes very long and slender. It is quite possible that this is not a distinct species.

G. neglectum Pat. Pileus sessile, 8–10 cm. broad, reddish-black, shining; context brown, tubes white, very short; spores globose, yellow, roughly echinulate, 11 — 12 μ . On trunks in Nicaragua.

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